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Contents

ENVIRONMENTAL EXTREMES AND ENDEMISM, *LeRoy E. Detling* 137

NOTEWORTHY SOUTH AMERICAN PLANTS, I AND II, *Paul C. Standley and Fred A. Barkley* 149

NOTES ON PACIFIC COAST MARINE ALGAE, *G. J. Hollenberg* 155

ON TWO PERENNIAL CAESPITOSE LEPIDIUMS OF WESTERN NORTH AMERICA, *Reed C. Rollins* 162

REVIEW: Ernest Brown Babcock, *The Genus Crepis* (Marion Ownbey) 165

NOTES AND NEWS: *A Possible Record of Quercus Morehus in Oregon*, Oliver V. Matthews; *News* 168

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ENVIRONMENTAL EXTREMES AND ENDEMISM

LeRoy E. Detling

One of the striking features of the distribution of plant species is the effect produced by varying intensities of the major environmental factors, mostly climatic, upon the composition of the plant association, and suggests one basis for the delimitation of geographical areas in studies of plant speciation and distribution. This effect is the subject of the present paper.

Several years ago a transect through western and central Oregon was selected for special investigation. This transect is fourteen miles wide and extends from the mouth of the Siuslaw River on the Oregon coast in a general easterly direction to a point between Redmond and Prineville, a distance of about 160 miles. In its wide extent from the coastal dunes and headlands, through the humid slopes and high peaks of two mountain ranges, to the continental plateau of central Oregon, it probably includes as many and as varied environments as can be found within the same distance anywhere in the Pacific Northwest.

A profile of the transect (fig. 1) shows first, beginning at the western end, a narrow strip composed of dunes in various stages of maturity cut through on the north by Heceta Head, a massive igneous intrusion forming a rocky headland. This strip is flanked on the east by the relatively low Coast Range, whose highest points in this region do not exceed 3000 feet. Beyond this is the Willamette Valley, its floor averaging perhaps 450 feet in elevation. To the east of this valley rises the Cascade Range, deeply dissected by the valleys of the McKenzie River and its tributary, White Branch. In general, its peaks do not surpass 5000 or 6000 feet in altitude, with the highest points, the Three Sisters, slightly over 10,000 feet. East of the Cascades the transect extends out over a plateau of about 3200 feet elevation, from which rise several prominences. One of these, Powell Butte, reaches approximately 5600 feet.

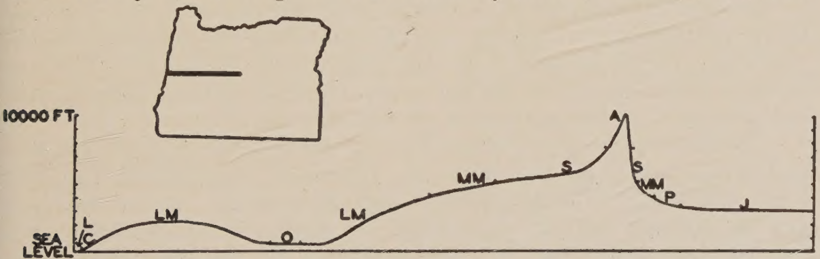

Fig. 1. Profile of the transect, showing relative positions of the vegetation zones.

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A striking variation in climate is due to the prevailing westerly winds from the Pacific Ocean which pass over two parallel mountain ranges, giving rise to an oceanic climate west of the Cascades with abundant rainfall and moderate temperatures at the lower altitudes and heavy snowfall in the higher mountains, and a continental climate on the plateau east of the Cascades with much reduced precipitation and greater extremes of temperature.

Climatic Factors

Source of the Data. The climatic data used in this investigation are based upon the annual summaries issued by the United States Weather Bureau. The factors which have been considered are: (1) average annual precipitation, (2) average precipitation for the combined months of June, July and August, (3) average minimum temperatures for the month of January, and (4) average of the maximum temperatures from April to September, inclusive.

Soil texture, slope of the terrain, conditions of light and shade, and other environmental factors have an important bearing on the constitution of the flora, but their effect in this area is largely local and they are left for later investigation. Some exception has been made in the case of soil salinity in the Littoral Belt, for reasons to be made clear later.

Owing to the large area included in the transect, the relative inaccessibility of the higher elevations during the winter months, and the lack of assistance in carrying on the project, it has not been feasible as yet to set up recording instruments throughout the transect for the collection of climatic data.

Climatic records for a number of years are available for the following points on the transect: Florence, Deadwood, Eugene, Vida, McKenzie Bridge, Sisters and Redmond. These stations are so located that it is possible to construct from their data curves for precipitation and temperatures for the whole transect. For some points in the higher elevations between McKenzie Bridge and Sisters, where local temperature differentials are important, it has been impossible to obtain these data directly. For this area temperatures have been computed on the basis of the general formula of a decrease of 3.3° F. for each increase of 1000 feet in altitude (Finch and Trewartha, 1942, p. 48). The gradients so computed are found to be in harmony with temperatures recorded from stations at comparable altitudes and locations in the Central Cascade area.

Precipitation. Annual rainfall (fig. 2) at the coast is about 70 inches; ascending the west slope of the Coast Range this increases to a maximum of over 90 inches, decreasing rather abruptly over the east or leeward slope to about 30 inches. On the west slope of the Cascade Range precipitation again increases from 37 inches at Eugene to 71 at McKenzie Bridge. East of the Cascade summit we again find a rapid decrease in annual precipitation, with 16 inches at Sisters, a few miles from the base of the mountains, and less than 8 inches at Redmond, 19 miles farther out on the plateau.

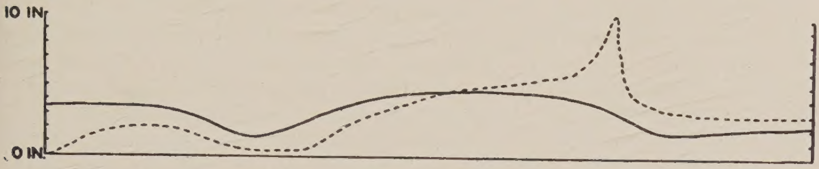

Fig. 2. Annual precipitation (transect profile in broken line).

From the standpoint of the maintenance of a particular flora the seasonal distribution of precipitation is extremely important. Throughout the transect most of the precipitation occurs during the months from October to April, but the amount of soil moisture probably does not become critical for any plant species before June. The term "summer rainfall" as used in this paper refers to the total for the months from June through August, by which time most of the vegetative growth and seed production of plants in this region have been completed.

The curve of summer rainfall for the transect (fig. 3) is similar to that of the total annual amount in that it shows two maxima, one on the west slope of each of the mountain ranges. The chief difference lies in the fact that the greater maximum of summer rainfall occurs in the Cascades rather than in the Coast Range.

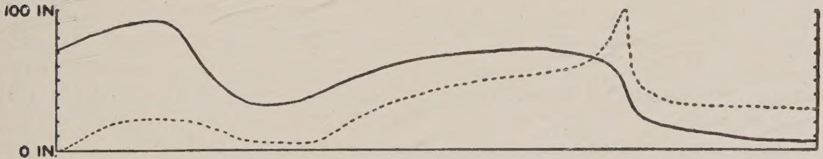

Fig. 3. Summer precipitation.

Temperature. The usual effect of low temperature in limiting the distribution of a plant species is winter-killing, and it is obvious in this case that it is the absolute low temperature which is actually the limiting factor. However, it would have been difficult, if not impossible, to obtain these particular data for most of the transect. For the purposes of comparison for which it is to be used in this study the average of the lowest temperatures for the coldest month of the year should reflect sufficiently well the extremes to which the winter temperatures fall in the various parts of the transect. The minimum temperatures referred to in the following pages are the averages for a period of years of the minimum temperatures recorded for the month of January, the month in which the lowest minima are recorded for all stations on the transect.

The importance of high temperatures for plant growth lies in the total amount of heat supplied in a given length of time. Here again, due to lack of recorded data, it has been impossible to determine this summation of temperature for any of the stations along the transect. Records are available, however, for the average maximum temperature for every month of the year, and the total of these temperatures during the growing season should reflect with sufficient accuracy for our purpose the variation in total solar heat among the vegetation areas under consideration. We have considered the months from April to September, inclusive, as the growing season. Instead of attempting to approximate a true summation of temperatures for this period we have reduced them to a more readily obtainable average of the maximum daily temperatures for the six months.

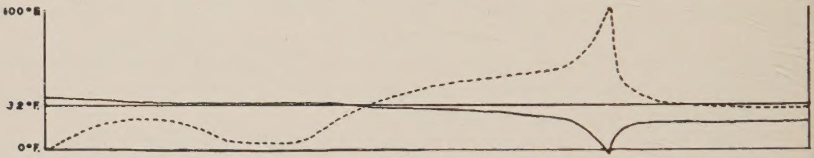

Fig. 4. Average January minimum temperature.

Disregarding local variations, we may make the following general statements regarding temperatures on the transect:

Average January minima (fig. 4) are highest at the coast, gradually falling as we go inland and as we ascend to the summit of the Cascade Range. East of the summit winter temperatures rise as we descend to the plateau, although even here they do not reach the high level prevalent over so much of the area west of the Cascades.

Maximum summer temperatures (fig. 5) are relatively low (64.1° F.) at the coast. These increase eastward over the Coast Range until a first maximum (75.6° F.) is reached in the McKenzie Valley, after which they decrease as one ascends the Cascade Range. On the east slope of this range summer temperatures again rise until the highest maximum for the transect (76.3° F.) is reached near Redmond.

Plant Associations

Data on the distribution of plant species are based largly upon collections and field observations made by the writer over a period of several years. This has been supplemented by study of other collections in the herbarium of the University of Oregon when the collectors' ecological data have been sufficiently full and definite to warrant their use. Distributional data drawn from collections made on the transect have been checked frequently by observations made in field work in adjacent localities in western and central Oregon.

The listing of species to be found on the transect is by no means complete. However, while continued field work will undoubtedly reveal more species, they will be scattered through all the associations, and their number will not be so great as to affect appreciably the relative value of the data or the conclusions to be drawn from them. This preliminary work is based upon 634 species and subspecies of spermatophytes, representing 275 genera.

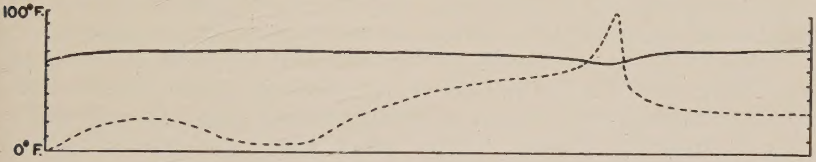

Fig. 5. Average summer maximum temperature.

The plant associations used in this study are the major ones of the region. They are the ones which have evolved in response to combinations of the major climatic factors. They sometimes coincide with forest types, where these mark the more important environmental differences. However, these larger units have not always been found useful as a basis for zone delimitation in the present study. In some cases a certain group of plant species is quite uniformly associated with a single dominant tree species, such as the western juniper. In the Douglas fir forest, on the other hand, the dominant species is accompanied by a well-marked association in its upper limits which is not found in its lower, each of these associations being clearly dependent upon certain climatic factors for its existence. The zones used here, then, have been determined not by the presence of any one indicator species, but rather by an association of species due to major climatic factors. Smaller associations, dependent upon local conditions, are not recognized.

In the following brief summary of the vegetation zones as treated in this study we have listed the "indicator association," i.e., the association of species characterizing that particular zone. It is, of course, to be understood that all the species here listed for any one indicator association may not always be present in that association. On the other hand, the presence in a given area of only one or two members of an indicator association cannot always be considered sufficient to mark the existence of the zone in which they ordinarily occur.

Littoral Belt. This belt is restricted to the coastal dunes, headlands and tide flats, where the vegetation is subjected to the constant winds, shifting sands, brackish water, salt spray and other direct influences of the ocean. Its indicator association is composed of *Carex macrocephala, Convolvulus soldanella, Lupinus littoralis, Abronia latifolia, Lathyrus littoralis, L. maritimus, Glehnia leiocarpa, Fragaria chilensis* and *Potentilla anserina.*

Coastal Forest. In that section of the Oregon coast covered by the transect this association extends but a short distance inland from the previous one. It is better developed and more extensive farther northward. On the whole, it is a dense forest. Climatic conditions are favorable to the formation of sphagnum bogs. The zone is marked by the presence of *Picea sitchensis, Pinus contorta, Myrica californica, Salix Hookeriana, Vaccinium ovatum, V. uliginosum, Chrysamphora californica* and *Ledum columbiananum.*

Oak Woodland. This type occurs in relatively small areas in the Willamette Valley and on the lower west slopes of the Cascades. It frequently occurs as a successional stage preceding the Lower Montane Forest, but at other times is apparently the climax association, and as such constitutes a northern extension of the deciduous woodland of the Umpqua and Rogue River Valleys of southern Oregon. The zone is here taken to include the open meadows and grasslands and exposed rocky hillsides, whose flora includes largely the same species as those found in the woodland proper. Indicator association: *Quercus Garryana, Q. Kelloggii, Arbutus Menziesii, Rhus diversiloba, Rosa nutkana, Potentilla gracilis, Dichelostemma pulchellum* and *Fritillaria lanceolata.*

Lower Montane Forest. This comprises the Douglas fir forest from its lower limit up to an altitude of about 4000 feet. It does not occur on the east slope of the Cascade Range. The indicator association is made up of *Pseudotsuga taxifolia, Acer circinatum, Cornus Nuttallii, Vaccinium parvifolium* and *Berberis nervosa.*

Middle Montane Forest. The Douglas fir forest from about 4000 feet to its upper limit, while containing many of the species found in the preceding zone, is characterized by the presence of a number of species not found in its lower elevations. This zone occurs on both slopes of the Cascades, but the areas occupied by it on the two slopes are separated from one another by the Subalpine Forest above them. On the east slope *Pseudotsuga* is largely replaced by *Abies grandis.* Characteristic species of the Middle Montane Forest are *Pseudotsuga taxifolia, Abies grandis, A. procera, Acer glabrum, Garrya Fremontii, Gaultheria ovatifolia, Vaccinium membranaceum, Calochortus Lobbii, Eriogonum compositum* and *Cornus canadensis.*

Subalpine Forest. The Subalpine Forest occupies a relatively narrow strip along the summit of the Cascades, extending up to timberline, and occurs on the summits of some of the more isolated peaks that rise up out of the lower zones, such as Horsepasture and Carpenter Mountains. The association marking the zone is made up of *Tsuga Mertensiana, Abies lasiocarpa, A. amabilis, Pinus contorta Murrayana, P. albicaulis, Vaccinium scoparium, Phyllodoce empetriformis, Cassiope Mertensiana, Luetkea pectinata* and *Vaccinium deliciosum.*

ALPINE TUNDRA. All vegetation above timberline may well be included in a single association. On this transect, tundra is restricted to a few peaks which reach about 7000 feet elevation or more. The highest of these are the North and Middle Sisters, both of which slightly exceed 10,000 feet. The indicator association of this zone consists of *Hulsea nana, Collomia Larsenii, Polemonium elegans* and *Oxyria digyna.*

PONDEROSA PINE FOREST. The whole belt dominated by ponderosa pine is included in this zone. It occupies the lower east slopes of the Cascades and the adjacent plateau, extending approximately from 3200 to 4000 feet. Its indicator association is composed of *Pinus ponderosa, Purshia tridentata, Ceanothus velutinus* and *Arctostaphylos patula.*

JUNIPER WOODLAND. This association occupies the plateau adjoining the Ponderosa Pine Forest. Its flora is essentially the same as that of the sagebrush plains or desert shrub formation to the east, but includes a notable stand of western juniper. The zone is characterized by the presence of *Juniperus occidentalis, Artemisia tridentata, Chrysothamnus* spp., *Astragalus* spp. and *Lupinus corymbosus.*

Hereafter, the names of these zones may be abbreviated as follows: L, Littoral Belt; C, Coastal Forest; O, Oak Woodland; LM, Lower Montane Forest; MM, Middle Montane Forest; S, Subalpine Forest; A, Alpine Tundra; P, Ponderosa Pine Forest; J, Juniper Woodland.

In any consideration of the effectiveness of the environment in determining the constitution of a given plant association we must have some acceptable criterion for judging the distinctness of that association, i.e., the degree of difference between it and any other association. The most reasonable basis for such judgment would seem to be the number of species endemic in any given association or zone. If environmental selection has been rigorous we should expect to find more highly specialized species comprising the flora of an area, in other words, more species which can grow only in that set of environmental conditions. The actual number of species endemic in an association is, of course, less significant than the percentage which these comprise of the total number occurring in it. The term "endemic," as employed here, simply means restricted to the area in question, with no reference to breadth or narrowness of range, or any other peculiarities of distribution. The number of endemics for each zone of our transect, and the percentage which this number represents in the total flora of that zone are shown in the following table:

Table 1. Percentage of Endemism in the Vegetation Zones

	No. endemic species	% of total
Littoral Belt	27	51
Coastal Forest	14	17
Oak Woodland	61	41
Lower Montane Forest	74	27
Middle Montane Forest	12	7
Subalpine Forest	69	43
Alpine Tundra	9	53
Ponderosa Pine Forest	20	27
Juniper Woodland	57	64

On the basis of these figures the Juniper Woodland is the most distinctly marked of all the associations, followed by the Alpine Tundra and the Littoral Belt, while the Middle Montane Forest is the least so.

THE ASSOCIATION-ENVIRONMENT RELATION

This relationship between the vegetation zones and the various environmental factors is best observed when the east and west slopes of the Cascade Range are treated separately. The following two tables (tables 2 and 3) present for each vegetation belt the range of each of the four climatic factors under consideration here. Since the Middle Montane is a discontinuous zone, the ranges of its climatic factors are treated separately for its east and west slopes. In the case of the Subalpine Forest and Alpine Tundra, since their areas are continuous over the summit, the ranges of the climatic factors include the extremes for both slopes. Precipitation is given in inches, temperatures in degrees Fahrenheit.

The data of the foregoing tables can be translated into graphs so constructed as to show the relative position of each zone in the whole range of any given climatic factor (figs. 6 and 7). The vegetation zones on each slope are arranged in ascending order from the lowest in elevation to the highest. The left-hand margin of the graph represents in each case one extreme of each of the factors, and the right-hand margin the other extreme. Each bar of the graph represents that portion of the total range of a factor which is included within the zone indicated, as well as its relative distance from each of the extremes.

Bearing in mind the figures of Table 1, on the degree of endemism in the flora of the various associations, an examination of the foregoing graphs reveals some interesting and significant facts.

Considering first the east slope, it will be noted that the highest percentages of endemism occur at the extremes of the slope, viz., 64% in the Juniper Woodland and 53% in the Alpine

Tundra. Endemism decreases as one approaches the middle altitudes, with 43% in the Subalpine Forest and 27% in the Ponderosa Pine Forest. The lowest degree of endemism, 7%, is found in the zone which occupies the middle position on the slope, i.e., in the Middle Montane.

TABLE 2. RANGE OF CLIMATIC FACTORS IN THE EAST SLOPE ZONES

	Annual precipitation	Summer precipitation	January min. temp.	Summer max. temp.
J	7.7–16.7	1.7–2.0	20.0–20.8	72.9–76.3
P	16.7–24.5	1.7–2.5	17.4–20.0	71.1–72.9
MM	24.5–45.0	2.5–3.2	15.5–17.4	69.8–71.1
S	45.0–71.2	3.0–4.6	6.2–15.9	63.7–70.0
A	36.0–64.5	3.0–3.9	−1.8– 7.2	57.3–63.7

TABLE 3. RANGE OF CLIMATIC FACTORS IN THE WEST SLOPE ZONES

	Annual precipitation	Summer precipitation	January min. temp.	Summer max. temp.
L	69.4	3.5	38.5	64.1
C	69.4–72.0	3.5–4.0	38.0–38.5	64.1–64.5
O	32.0–40.0	1.5–2.5	32.1–34.5	72.0–72.5
LM	32.0–92.0	1.5–4.6	20.9–38.0	64.5–75.6
MM	66.0–72.0	3.9–4.6	15.9–20.9	70.0–72.5
S	45.0–71.2	3.0–4.6	6.2–15.9	63.7–70.0
A	36.0–64.5	3.0–3.9	−1.8– 7.2	57.3–63.7

Now it may be noted that the climatic factors also form a gradient on the slope, with the greater number of extremes occurring in the Juniper Woodland and Alpine Tundra, the least extreme conditions being found in the Middle Montane. More specifically, all four climatic factors reach one of their extremes in the Juniper Woodland. In the Alpine Tundra two factors, January minimum and summer maximum temperatures, reach one extreme, and the amount of precipitation is exceeded in only one other zone. In the Subalpine Forest the two precipitation factors are at one of their extremes while the summer and winter temperatures are roughly about midway of their extremes. The general average of extremeness for all factors is less in the Subalpine Forest than in the Tundra. In the Ponderosa Pine Forest only one factor reaches an extreme. In the middle Montane Forest no factor is at its extreme; the graph shows all the bars for this association to be grouped fairly well toward the mid-points of the factor ranges for the whole gradient.

On the west side of the Cascade divide, if we leave for later consideration the Littoral Belt and Coastal Forest, we find a situation quite comparable with that on the east slope, in that we

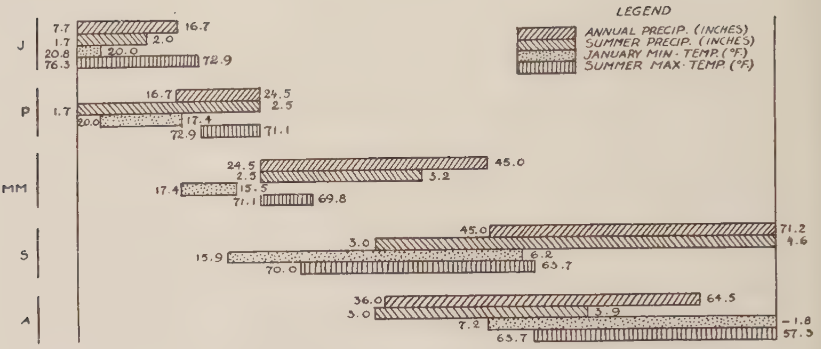

Fig. 6. Range of climatic factors in the east slope zones. (Based on Table 2). J--Juniper Woodland. P—Ponderosa Pine Forest. MM—Middle Montane Forest. S—Subalpine Forest. A—Alpine Tundra.

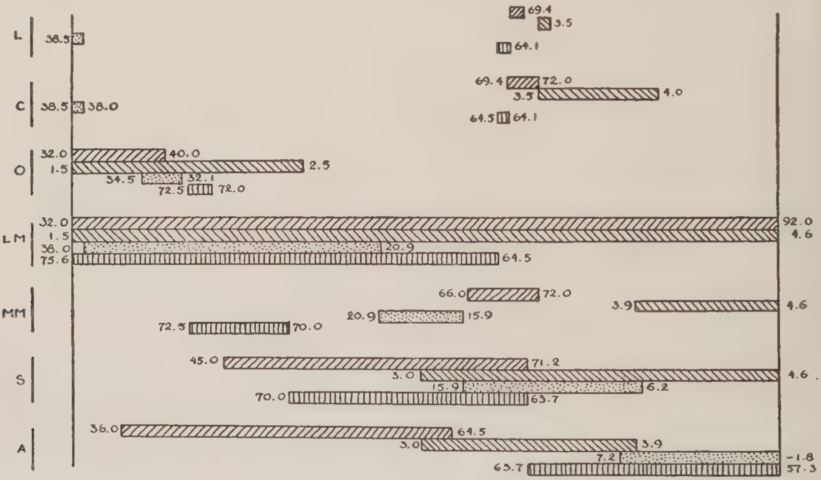

Fig. 7. Range of climatic factors in the west slope zones. (Based on Table 3). L—Littoral Belt. C—Coastal Forest. O—Oak Woodland. LM—Lower Montane Forest. MM—Middle Montane Forest. S—Subalpine Forest. A—Alpine Tundra.

have a gradient of climatic factors from the Oak Woodland up to the Alpine Tundra, coupled with a high degree of endemism in those plant associations where most of the climatic extremes occur and a low degree of endemism where climatic conditions are for the most part moderate. The Tundra combines the highest degree of endemism, 53%, with extremes in both summer and winter temperatures and moderate precipitation. The Subalpine Forest and Oak Woodland have almost the same degree of endemism, 43% and 41% respectively. In the former it will be noted that one factor, summer rainfall, reaches one of its extremes, while the lower extremes of both summer and winter temperatures in this zone are surpassed only in the adjacent Tundra. The graph shows how in the Oak Woodland all factors are grouped at or near one of their extremes. The Lower Montane Forest is moderate in degree of endemism (27%); two of the climatic factors, annual and summer precipitation, cover in this one association the entire range for the west slope, while temperatures range from an extreme at one end well up into the middle portion of the total gradient. The Middle Montane Forest, with only 7% endemism, the lowest on the slope, has an extreme in only one factor, viz., summer rainfall, the other three being scattered through the middle portion of their ranges in this zone.

The foregoing data lend support to an hypothesis which, in-so-far as this transect and the four climatic factors under consideration are concerned, might be stated thus: The degree of endemism in the flora of a given area is directly correlated with the total number of environmental factors reaching their extremes in the area. The greater the number of factors which reach or approach one of their extremes in an area, the greater will be the degree of endemism in the flora of the area.

Two questions regarding the west slope associations present themselves. The first and undoubtedly the most obvious one is: Why does the Lower Montane Forest have only 27% endemism when the association embraces not only one extreme of summer maximum temperature and practically one extreme of January minimum temperature, but also *both* extremes of the two precipitation factors? The answer lies in the very fact that climatic conditions in the association are so varied that they do reach both extremes or at least have a very wide range. It will be noted that in the graph the bars for the Lower Montane Forest overlap all or many of the corresponding bars in adjacent associations. This means that in the various parts of its wide range where the climate approaches that of other associations there will be an exchange of species between the zones with a resultant decrease in the number of endemic species.

The second question arises when it is noted that in the Oak Woodland the range of each climatic factor is entirely overlapped by the range of the same factor in the Lower Montane Forest. Since the climate of the Oak Woodland is thus reproduced in certain parts of the Lower Montane Forest why does not this area support such a forest? The answer may be sought in the fact that all the factors in the woodland are so near to the extremes present in the Lower Montane that any other environmental condition that increases the effect of one of these extremes will be sufficient to change the whole plant association. Such a condition is the shallow soil frequently found on the low hills of the

Willamette Valley, as well as increased insolation due to slope of the terrain. Early drying of these soils decreases the effectiveness of annual and summer precipitation and shifts an already marginal Lower Montane Forest into an Oak Woodland. It is worthy of note that in the Umpqua and Rogue Valleys, where the Oak Woodland occupies a much deeper soil, the annual and summer precipitation both fall below the lowest extremes for these factors in the Willamette Valley.

Consideration of the Coastal Forest and the Littoral Belt has been left for this time since the climatic factors in these associations do not form a part of the regular climatic gradient on the west slope of the Cascades. In the case of the Coastal Forest, however, as the graph shows, only one of its climatic factors, viz., January temperature, approaches an extreme, the others being definitely median in their position. It is therefore in keeping with the hypothesis advanced above that the distinctness of the flora in this forest is represented by only 17% of endemism.

At first glance the Littoral Belt would seem to offer an exception to our hypothesis. Its climatic factors have practically the same positions as do those of the Coastal Forest, yet the Littoral flora has an endemism of 51%, second only to that of the Alpine Tundra among the west slope associations. However, bearing in mind that one of the main features of the environment of the Littoral Belt is soil salinity of such degree as to create a condition of extreme physiological drought, we see that actually the availability of both annual and summer precipitation is so modified that we could well consider them to be at their lower extreme here. This low extreme of available soil moisture, coupled with the upper extreme of winter temperature, and the fact that summer temperatures are lower here than in any association except the Subalpine Forest and the Tundra, may easily explain the high degree of endemism in the Littoral association.

Since the summation of environmental extremes is so clearly reflected in the distinctiveness of floras in various geographical areas, this should be taken into account in our studies on the evolution of floras. To one familiar with areas of endemism, a survey of climatic maps shows that the centers of floral areas richest in endemic species coincide with areas in which occur the end points of a number of climatic gradients. It is clear that our investigations on species distribution and the evolution of species and subspecies should be based upon climatic areas so constituted. As a specific example, taxonomic and distributional studies on one of the sections of the genus *Lupinus*, well represented and widespread in the Pacific Northwest, are being carried on by the writer. These studies have this type of area as their basis, and it has been found that the geographic pattern of species and subspecies follows closely the pattern of summations of environmental extremes.

Summary

The degree of endemism in the nine major plant associations on a transect through western and central Oregon is compared with annual precipitation, summer precipitation, January minimum temperature and summer maximum temperature in the same associations. It is found that the higher percentages of endemism occur in those associations in which the greater number of climatic factors reach one of their extremes. The hypothesis is advanced that the degree of endemism in the flora of a given area is directly correlated with the total number of environmental factors reaching their extremes in the area. It is pointed out that the centers of floral areas richest in endemic species coincide with areas in which occur the end points of a number of climatic gradients, and it is suggested that taxonomic and distributional studies be based upon geographic areas constituted along these lines.

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University of Oregon, Eugene

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NOTEWORTHY SOUTH AMERICAN PLANTS, I AND II

Paul C. Standley and Fred A. Barkley

In working over portions of recent collections of plants from Peru and Bolivia collected by H. E. Stork, O. B. Horton, W. J. Eyerdam, J. Soukup S. S., C. Vargas C., and T. H. Goodspeed, five specimens have appeared which are sufficiently distinct from the known species of that area that they seem worthy of description.

The types of these are all deposited in the Herbarium of the Chicago Natural History Museum.

Phoradendron Storkii Barkley, sp. nov. Frutex glaber, parasiticus, dioicus; foliis coriaceis, lanceolatis, oppositis, 130 mm. longis, 20 mm. latis, basi cuneatis, decurrentibus, subsessilibus, apice obtusis, 3–5-nerviis; cataphyllis 2, late deltoideis, ad nodum primum ramis primarii; internodiis basi tetrangularibus (infimis exceptis), apice planis et late alatis (alis caulies latitudine aequantibus); inflorescentiis erectis et in axillis foliorum solitariis; pedunculis circa 5 mm. longis; bracteis 2 inflorescentiam subtendentibus; inflorescentiis 1 ad 3 cm. longis; petalis 3.

Shrubby, dioecious parasite on trees with stems to 60 cm. long, nodes of stem yellow and the remainder of stem and leaves chlorophyll green; leaves thinly coriaceous, lanceolate, opposite, 130 ±

mm. long, 20 ± broad, base cuneate, decurrent, subsessile, tapering gradually to the narrowly obtuse apex, 3 to 5 nerved from near the base; a pair of very broadly deltoid cataphylls at the first node of each main branch; all but the lowest internodes obscurely tetrangular at the base becoming flattened and broadly alate at the apex (the wings equal to the stem in width); inflorescences erect and solitary in the axils of the leaves; peduncles about 5 mm. long; a pair of broadly deltoid bracts subtending the inflorescence; inflorescence 1 to 3 cm. long; petals 3; fruit white, cylindric-ovoid, 2.5 mm. long, 1.5 mm. broad.

Type. Altitude 3200 m., 10 km. northwest of Socota, Depto. Cajamarca, Peru, December 10, 1938, *H. E. Stork & O. B. Horton 10133.*

This species apparently is closely related to *Phoradendron Mathewsi* Trel. and *P. semiteres* Trel., but it differs in leaf, stem, and inflorescence characters.

Cleome Eyerdamii Standley & Barkley, sp. nov. Suffrutex, 10 ad 30 cm. altus; foliis trifoliolatis; foliolis 3 (–5?), obovatis, 1–3 cm. longis, cuneatis, sessilibus, ad apicem subacutis; pedicellis circa 1.5 cm. longis, puberulentis glandulosis; capsulis glabris, circa 2 cm. longis, 3–5 mm. latis; stipitibus circa 1 mm. longis.

Bush or perennial herb 10 to 30 cm. tall with woody stem and peculiar odor; leaves trifoliolate, petiole slightly exceeding the lamina in length; leaflets 3 (–5?), obovate, 1–3 cm. long, half as wide, cuneate, sessile, at apex subacute; a pair of short stipular spines at the base of the petiole; stems, leaves, bracts, and pedicels densely glandular puberulent; bracts conspicuous, persistent, ovate, about 1 cm. long, subsessile; sepals broadly lanceolate, half as long as the petals, glandular puberulent; petals white, clawed, obovate, about 6 mm. long; pedicels in fruit about 1.5 cm. long, glandular puberulent; fruit glabrous, stipe about 1 cm. long, capsule about 2 cm. long, 3–5 mm. broad.

Type. About 5 km. southeast of Cochabamba, Depto. Cochabamba, Bolivia, March 20, 1939, *W. J. Eyerdam 24917.*

This species is similar to *Cleome psoraleaefolia* DC., but differs most notably in the glabrous fruit, in its capsules which are only about half as long, in its dense glandular puberulence in contrast to the sparse long pubescence, and in its more broadly ovate bracts which are less acute at the apex.

Psittacanthus Hortonii Standley & Barkley, sp. nov. Frutex parasiticus ad 60 cm. altus, glaber, paulum ramosus; ramis longis, laevibus, sparse striatis; foliis alternatis, cuneato-obovatis, 25 mm. longis, 9–16 mm. latis, viridibus aliquid glaucis, subsessilibus, truncatis, ad apicem emarginatis, mucrone nigro parvo; floribus 1–3, axillaribus, pedicellis erectis, circa 5 mm. longis; petalis 6, rubris, linearibus, acutis, primo coalescentibus, deinde parte

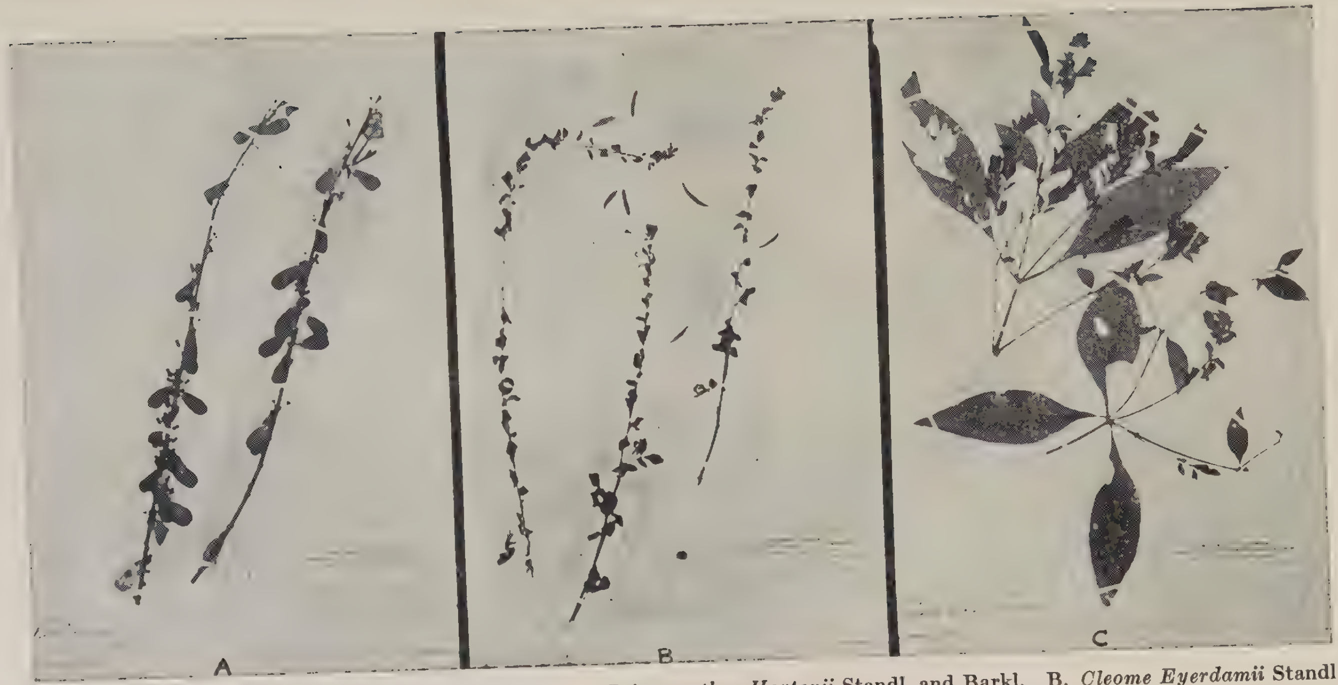

Plate 20. Types of South American plants. A. *Psittacanthus Hortonii* Standl. and Barkl. B. *Cleome Eyerdamii* Standl. and Barkl. C. *Beloperone Soukupii* Standl. and Barkl. (Deposited in the Herbarium of Chicago Natural History Museum.)

supera valde reflexa; filamentis filiformibus, subulatis, petala aequantibus; antheris flavis; fructu fulgente, nigro, globoso, circa 7 mm. longo.

Parasitic shrub to 60 cm., glabrate, little branched, branches long, smooth, scarcely striate; leaves alternate, cuneate-obovate, 25 mm. long, 9 to 16 mm. broad, green but somewhat glaucous, coriaceous, three-nerved from the base, subsessile, truncate, emarginate at apex with a small black mucro about 0.5 mm. long; flowers scarlet, axillary, 1 to 3, the pedicels erect, about 5 mm. long; cup about 2.5 mm. deep, with three deltoid teeth; calyx 4 mm. long, 2 mm. broad, margin entire; petals 6, scarlet, linear, acute, at first coalescent, later with upper third strongly reflexed; filaments filiform, subulate, adnate to the petals two-thirds of their length, equalling the petals in length; anthers yellow, versatile, two celled, opening by two longitudinal slits, 4 mm. long; stigma capitate, style filiform, 25 mm. long; fruit shiny, purplish black, globose, about 7 mm. long.

Type. Huacho, 8 km. north of Huánuco, Depto. and Prov. Huánuco, Peru, October 15, 1938, *H. E. Stork & O. B. Horton 9400.*

This plant is closely related to *Psittacanthus cuneifolius* (R. & P.) G. Don, from which it differs most markedly in the leaves which are three to five times as broad as in that species. There is no indication of the swelling at the nodes which is usually seen in *P. cuneifolius.*

Beloperone Soukupii Standley & Barkley, sp. nov. Herba perennis, ad basem decumbens; foliis 2–4 cm. latis, 4.5–10 cm. longis, anguste ovatis, subrevolutis subintegrisque, apice subacuminata, basi cuneata, in petiolum decurrentia; petiolis 2–3 cm. longis, setoso-puberulentis; spicis 2–6 cm. longis, circa 1 cm. latis; bracteis lanceolatis vel alte oblanceolatis, 2–3 cm. latis, 8–9 mm. longis, acuminatis; calycis lobis viridibus, linearibus, 1 mm. latis, 8 mm. longis, acuminatis; corolla puberulenta, 17 mm. longa; staminibus corollae subaequalibus; capsulis puberulentis, circa 5 mm. longis, recurvis.

Perennial herb, somewhat trailing, decumbent at base, minutely subappressed setose; stem slender, branched, striate, quadrangular above; internodes 5 to 7 cm. long; leaves petiolate, 2 to 4 cm. broad, 4.5 to 10 cm. long, narrowly ovate, subrevolute and subentire at margin, tapering at both ends, apex acute to subacuminate, base cuneate, long decurrent on the petiole, finely and sparsely setose-puberulent above and below, pale green and with an almost metallic lustre when dry; flowering branches from the axils of the uppermost leaves, with a single short-peduncled spike or with several subsessile spikes; spikes 2 to 6 cm. long, about 1 cm. broad; bracts lanceolate to broadly oblanceolate, 2 to 3 mm. broad, 8 to 9 mm. long, acuminate, sparsely pilose on the outer surface, glabrous on the inner surface, ciliate, pinnate-veined with

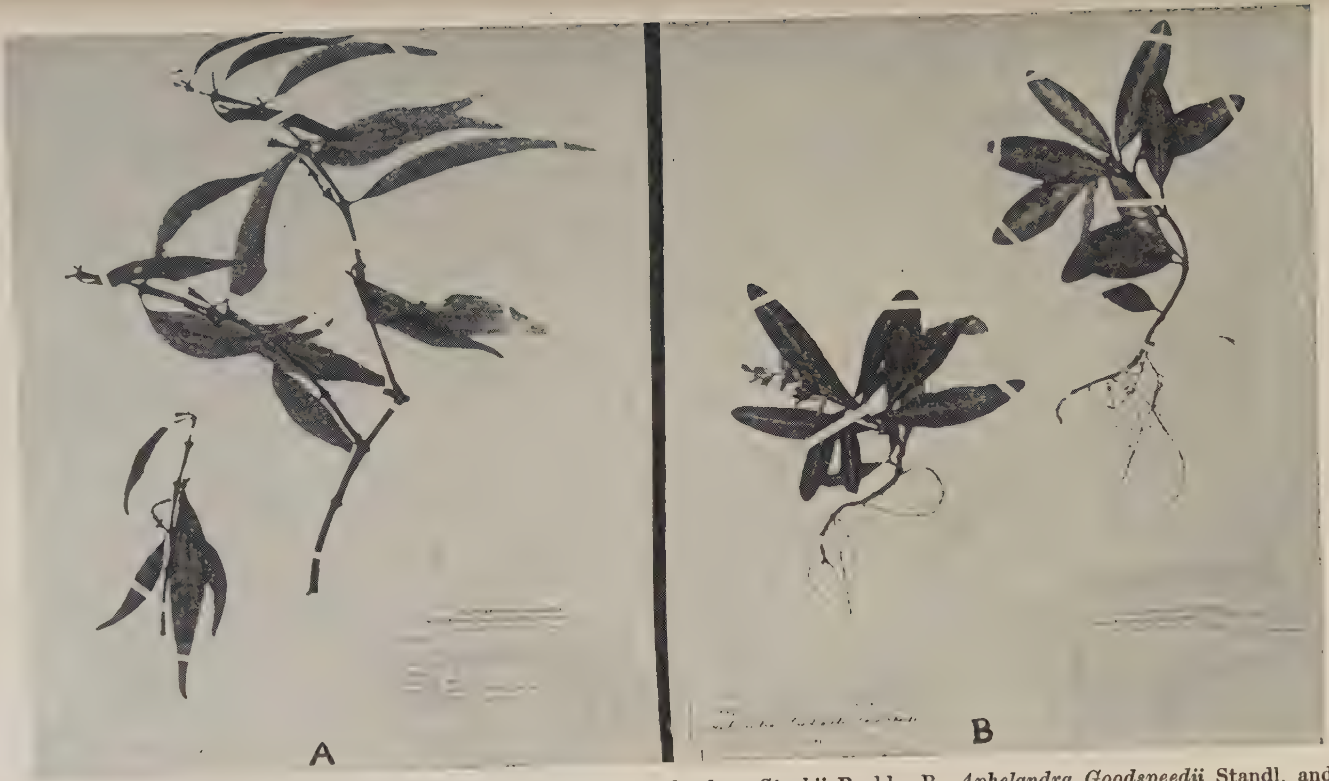

Plate 21. Types of South American plants. A. *Phoradendron Storkii* Barkl. B. *Aphelandra Goodspeedii* Standl. and Barkl. (Deposited in the Herbarium of Chicago Natural History Museum.)

about 3 pairs of veins; calyx-tube essentially obsolete, calyx lobes green, linear, 1 mm. broad, 8 mm. long, acuminate, glabrous on inner surface, pilose on outer surface, ciliate; corolla puberulent, 17 mm. long, white tinged with pink, tube 11 mm. long, 1.5 mm. broad, lobes unequal; stamens nearly as long as the corolla, anthers narrow, 1.5 mm. long; capsule puberulent, greenish, about 5 mm. long, recurved.

Type. Altitude 630 m., Depto. Huánuco, 10 km. downstream from Tingo María, Peru, October 28, 1938, *H. E. Stork & O. B. Horton 9532.* Weedy perennial herb, partly trailing, along edges of forest in partial sun, in forest mold.

This species closely resembles *Beloperone cochabambense* Rusby in general habit and appearance, even to the metallic lustre of its leaves; however, its flowers are only half as long, the leaves somewhat broader, with longer petioles, longer and more slender spikes, and it has narrower and less pilose bracts, as compared to *B. cochabambense.*

Aphelandra Goodspeedii Standley & Barkley, sp. nov. Herba; caulis simplex, subprocumbens, nodis infirmis radicans, setosus; folia spatulato-lanceolata, apice obtusa, basi cuneata, integra vel subintegra, utrinque laxe setosa; spicae terminales, pedunculatae; bracteae imbricatae, adpressae, serratae, pilosae; bracteolae lanceolatae, acuminatae; sepalis lanceolatis, striatis.

Prostrate perennial herb up to 15 cm. high, the stem simple, subascending, rooting at the lower nodes, setose, the hairs subappressed; petioles 2 to 4 mm. long, densely pilose; lamina spatulate to lanceolate, 30 to 80 mm. long, 9 to 20 mm. wide, obtusely rounded at apex, cuneate and decurrent at base, entire or subundulate, when dry bluish above, grayish below, except whitish along costa and lateral veins, entire or subundulate, setose on both surfaces but more abundantly so below; flowers borne in one or more terminal spikes about 4.5 cm. long; the peduncle about 8 mm. long, pilose like the rachis, stem, and petioles; bracts green, lanceolate, acuminate, repand-serrate toward summit with about five pairs of teeth, 3 mm. wide, 12 mm. long, in fruit ovate-lanceolate, about 4 mm. wide, 12 mm. long, hirsute on the outer surface; bractlets lanceolate, acuminate, entire, puberulent, membranaceous-subhyaline, about 4.5 mm. long; calyx segments lanceolate, acuminate, entire, minutely ciliate on the margins, subhyaline, delicately striate-nerved, about 4.5 mm. long, 1 mm. wide; capsules about 7.5 mm. long, glabrous, seed four, the valves of the capsule recurved after dehiscence.

Type. Altitude 630 meters, Depto. and Prov. Huánuco, 10 km. downstream from Tingo María, Peru, November 2, 1938, *H. E. Stork & O. B. Horton 9597.*

This species appears to be closely related to *Aphelandra ornata* T. Anders. and *A. Seibertii* Leonard. *A. ornata* is a more upright plant, the leaves broadly lanceolate, subacute, glabrous except on the veins and with petioles about 15 mm. long, and the bracts are ovate with more and finer serrations. *A. Seibertii* has longer pilose stems, petioles, and inflorescence rachis, much larger ovate leaves, with finer and more abundant pubescence, and the bracts are much broader.

Chicago Natural History Museum Herbarium,
Chicago, Illinois.
The University of Texas Herbarium,
Austin, Texas.

NOTES ON PACIFIC COAST MARINE ALGAE

G. J. Hollenberg

Data concerning the distribution of marine algae on the Pacific Coast of North America are found chiefly in the various papers of Setchell and Gardner and in the more recent works of Smith (1944) and Dawson (1946). In the present paper the known range of a number of species is extended as a result of collections by the writer extending over a period of years. Unless otherwise indicated, the place records are from the coast of southern California and collection numbers are those of the writer.

Chlorophyceae

Ulvella Setchellii Dangeard, south of Redondo Beach, January, 1936, *1249;* Corona del Mar, March, 1938, *2243b.* This species, previously reported from Pacific Grove on the coast of central California (see Smith, 1944), is probably widely distributed along the coast. In both of the above collections as well as at various other times, this plant was found endophytic in the outer wall of *Amplisiphonia pacifica* Hollenberg, although it is apparently not limited to this host. Dangeard (1931) reported the Californian material of this species as growing in or on the wall of *Laurencia* sp. Observations on living material and parafine sections indicate that the Pacific Coast plant is endophytic, except in the very early stages of its development. The endophytic habit might be considered as reason for questioning the propriety of this generic designation.

Rhizoclonium riparium (Roth) Harvey, Corona del Mar, May, 1936, *1386;* Balboa Harbor, December, 1936, *1928.5.* Previous records are from Carmel along the coast of central California and northward (Setchell and Gardner, 1920). In the case of the first of these collections the plant formed extensive brownish masses on rocks in the midlittoral zone.

PHAEOPHYCEAE

ECTOCARPUS CHANTRANSIOIDES S. & G., Corona del Mar, October, 1942, *3288*. This plant, which was found at least twice in this general locality, seems not to have been recorded since first discovered by Setchell and Gardner (1925). It forms abundant brown hemispherical cushions several millimeters in diameter on boulders in the middle littoral zone. Among 30 cushions examined, nearly all bore plurangia, but no unilocular sporangia were found.

ECTOCARPUS CYLINDRICUS Saunders, on *Halidrys,* Corona del Mar, November, 1936, *1600;* on *Gelidium* and *Eisenia,* La Jolla, December, 1936, *2028a, 2028b;* on the stipe of *Eisenia,* Corona del Mar, December, 1939, *3051*. Although fairly common along the coast of southern California, this plant was previously known only from the type collection obtained by Saunders (1898) at Pacific Grove, along the coast of central California. However, *E. cylindricus* f. *codiophilus* S. & G. has been collected by Dawson (1945b) at La Jolla. *Eisenia* seems to be the commonest host. In one instance the *Ectocarpus* formed a patch two centimeters across.

DICTYOPTERIS JOHNSTONEI Gardner, from a large tide pool at medium high tide level on exposed rocky shore several miles south of Redondo Beach, October, 1935, *1021*. This specimen is 37 cm. high. Gardner's fragmentary specimen, the only one previously known, was only 7 cm. high. The present specimen has a stupose base as anticipated by Gardner's account (1940). The stipe is more prominent (5 cm. long) than in the type specimen and the main axes are much less branched and decidedly percurrent. A collection made from a high tide pool at Corona del Mar, November, 1934, *583,* seems to belong here also, although a few of the frond divisions are as much as 5 mm. wide.

RHODOPHYCEAE

GONIOTRICHUM CORNU-CERVI (Reinsch) Hauck, on *Herposiphonia* sp., Santa Cruz Is., April, 1936, *1339*. Previously reported for the Pacific Coast by Kylin (1925) from the vicinity of the Biological Station at Friday Harbor, Washington.

ERYTHROTRICHIA PULVINATA Gardner, on the usual host, *Codium fragile* Suhr., Emerald Bay, Laguna Beach, February, 1935, *649.5*. Previously known only from the Monterey Peninsula (Smith, 1944).

ERYTHROCLADIA SUBINTEGRA Rosenvinge, from Santa Cruz Island, April, 1936, *1367*. Previously reported as far south as Monterey (Kylin, 1941), recently from Baja California, Mexico (Dawson, 1945c), and probably the plant referred to without name by Dawson (1944a, p. 251) as occurring in the Gulf of California. The plant is locally common on various algae along with *E. irregularis* Rosenvinge.

Rhododermis elegans Crouan, was found growing on the stipe of *Cystoseira osmundacea* (Menz.) Ag. south of Redondo Beach, October, 1935, *1049;* and on the same host at White's Point, San Pedro, November, 1933, *330.* This plant was not previously known south of Monterey, where it is reported as occurring by Smith (1944). It is of frequent occurrence along the coast of southern California.

Cruoria pacifica Kjellman (?), on shells of turban snails, *Tegula* sp., Corona del Mar, October, 1935, *1065;* on rocks, Laguna Beach, December, 1935, *1170.* This species was previously reported only from Alaska (Kjellman, 1889), however, it is very imperfectly known and might well prove to belong to another genus. The plants from southern California have zonate tetrasporangia and clearly belong to the genus *Cruoria,* but cannot at present be identified with Kjellman's species with certainty.

Choreonema Thureti (Bornet) Schmitz, collected at Corona del Mar, December, 1937, *2231.* The writer has collected this plant a number of times along the coast of southern California. It has been previously reported from Laguna Beach by Guernsey (1912), from Guadalupe Island off the coast of Mexico by Setchell and Gardner (1930), and from the coast of Ecuador by Taylor (1945).

Grateloupia abbreviata Kylin, Santa Catalina Island, April, 1935, *762;* Point Vicente, near Redondo Beach, July, 1938, *2339;* Laguna Beach, May, 1941, *3176.* This plant was previously reported from La Jolla by Kylin (1941). It seems to be relatively common at certain seasons near high tide level on large waveswept rocks near Laguna Beach, where it has been collected a number of times.

Petrocelis franciscana S. & G., White's Point, San Pedro, October, 1938, *2376.* This species was previously reported as far south as San Luis Obispo County (Smith, 1944).

Gardneriella tubifera Kylin, near Santa Monica, July, 1935, *1279.* Until Dawson (1945c) reported this species from two points on the coast of Baja California, it had been recorded only from the Monterey Peninsula (Smith, 1944).

Hypnea californica Kylin, cast ashore near Santa Monica, July, 1935, *882.* This plant was previously reported only from the type locality at La Jolla (Kylin, 1941), and from Guerrero, Mexico (Taylor, 1945).

Gigartina papillata (Ag.) J. Ag., White's Point, San Pedro, October, 1938, *2390.* Until Dawson (1945c) reported this species from Punta Descanso, Baja California, Mexico, it had been recorded only as far south as Carmel Bay (Smith, 1944).

Rhodoglossum parvum Smith and Hollenberg, from Laguna Beach, March, 1936, *1295* and March, 1937, *2065.* This species was known previously only from the Monterey Peninsula (Smith and Hollenberg, 1943).

Binghamiella Forkii Dawson, on corallines, Laguna Beach, March, 1935, *658* (tetrasporic); on *Gelidium* sp., cast ashore near the isthmus, Santa Catalina Island, April, 1935, *787* (cystocarpic); on corallines, Laguna Beach, December, 1936, *1935a.* This plant was previously known only from the type locality, La Jolla (Dawson, 1944b).

Fauchea media Kylin, Santa Cruz Island, April, 1936, *1365;* Laguna Beach, March, 1936, *1293.* This plant was previously known only from the Monterey Peninsula (Smith, 1944).

Callithamnion Pikeanum var. pacificum (Harv.) S. & G., Point Magu, Ventura County, March, 1935, *738.* This variety was reported by Gardner (1927) as occurring from the Straits of Juan de Fuca northward.

Ceramium gracillimum Griffiths and Harvey, on corallines, Laguna Beach, December, 1936, *1943.* This plant has been collected frequently at this locality on large wave-swept rocks near high tide level. It is similar to if not identical with a plant reported by Setchell and Gardner (1930) from the Revilla Gigedo Islands under the name *C. transversale* Collins & Hervey. Dawson (1944a) identified as *C. gracillimum* a plant which he collected in the Gulf of California, but on account of the different habitat of the local plant the writer suspects that it may ultimately prove to be distinct from the plant described by Griffiths and Harvey.

Ceramium sinicola var. interruptum (S. & G.) Dawson, Laguna Beach, November, 1935, *1103;* Laguna Beach, December, 1936, *1932;* on oyster shells, upper Balboa Harbor, December, 1936, *1927.* This species was not previously known north of the type locality, Ensenada, Baja California, where it was first reported by Setchell and Gardner (1924).

Ceramium procumbens S. & G., Redondo Beach, August, 1934, *468.5;* from near Scripps Institution, La Jolla, December, 1936, *1972, 2035.* This species has not been reported since originally described by Setchell and Gardner (1924) from material collected in the Gulf of California. It seems common as an epiphyte along the coast of southern California.

Gymnothamnion elegans (Schousboe) J. Ag., Laguna Beach, November, 1935, *1101;* Corona del Mar, January, 1943, *3305.* This plant was previously reported from the Revilla Gigedo Islands by Setchell and Gardner (1930). It is of frequent occurrence on rocky coasts along the coast of southern California.

Ptilota filicina (Farl.) J. Ag. This plant occurs in the Dimmick collection from Santa Barbara. The Monterey Peninsula is given by Smith (1944) as the southern limit of its known range.

Anisocladella pacifica Kylin, from Laguna Beach, October, 1935, *1055* (male and sterile specimens); from near Santa Monica, December, 1935, *1197, 1198* (male and cystocarpic); Corona del Mar, February, 1940, *3089* (tetrasporic); Laguna Beach, November, 1942, *3290* (cystocarpic and tetrasporic). Until Dawson

(1945c) reported this plant from the coast of Baja California, Mexico, it had been known only from the Monterey Peninsula (Smith, 1944). Examination of isotype material from the Monterey region leaves no doubt that Kylin's plant is the same as those encountered more frequently farther south. The development of the secondary cell rows at the tips of the blades, with alternate emphasis in growth of the secondary cell rows on either side of the midrib, as described by Kylin (1941), is very characteristic. Cystocarpic and antheridial plants seem not to have been previously described. The cystocarps are commonly in pairs on either side of the midrib near the middle of the blade as far as length is concerned, but may also occur singly, and less frequently three may occur together on one blade. Antheridial areas usually occur as a single and relatively large pair near the tip of the blade.

Dasyopsis densa G. M. Smith. A specimen in the collection of Dr. L. N. Dimmick, which is housed in the Santa Barbara Museum of Natural History, is probably this plant. It was previously known only from the Monterey Peninsula (Smith, 1944).

Pogonophora californica J. Ag., Laguna Beach, February, 1935, *644*. This plant was described by J. Agardh (1890) from Santa Barbara. It was collected by Gardner (no. *2506*) as far north as Bodega Bay in Marin County. It was also collected by Dawson (1945b) at La Jolla and by Dawson (1945c) from Punta Descanso, Baja California, Mexico. It is of frequent occurrence along the coast of southern California.

Stromatocarpus Gardneri Setchell, on *Pterosiphonia dendroidea* (Mont.) Falk., Laguna Beach, March, 1936, *1289* (male, tetrasporic, and cystocarpic). The type collection was from near Santa Monica, where the plant was parasitic on *Pterosiphonia Baileyi* (Harv.) Falk. (see Setchell, 1923). Until Dawson (1945a) reported this plant from La Jolla, it was not recorded as having been collected since the type collection was made.

Choreocolax Polysiphoniae Reinsch, parasitic on *Lophosiphonia villum* (J. Ag.) S. & G., Laguna Beach, December, 1937, *2208*. Until Dawson (1945c) reported this plant from Baja California, Mexico, it had been known on the Pacific Coast of North America only from Sitka, Alaska (Saunders, 1901), and from the Monterey Peninsula (Smith, 1944). The writer has collected it several times on the coast of southern California.

Herposiphonia tenella (Ag.) Naeg., south of Redondo Beach, July, 1935, *981* (tetrasporic); Santa Catalina Island, April, 1935, *834;* Corona del Mar, October, 1937, *2146* (cystocarpic); Laguna Beach, December, 1936, *1929.5;* Redondo Beach, October, 1935, *1050*. This species is widely distributed. It was previously reported for the Pacific Coast of North America by Dawson (1944a) from the Gulf of California. It is locally quite common among other mat-forming algae in the upper tide level. Sometimes on spray-covered rocks in shallow tide pools it occurs by itself, in which case branching is sparse and it spreads horizontally on the rocks, forming thin patches several centimeters in diameter. The cystocarps are terminal or subterminal on the determinate branches as described by Børgesen (1918) but the branch is not continued as a slender projection as shown in his figure. In one case the plant seemed to lack trichoblasts entirely, but usually there is a brief but distinct tuft of widely branching trichoblasts at the tips of the determinate branches. Rhizoids arise at the distal ends of the pericentral cells as described by Børgesen. In the writer's experience, this seems to be a characteristic feature of the genus.

Herposiphonia secunda (Ag.) Naeg., from near Santa Monica, April, 1934, *443.1*. This species seems not to have been previously reported from the Pacific Coast of North America. Some investigators are of the opinion that this plant should be considered as a variety under the preceding species. Børgesen (1918), who considers it as a separate species, depends chiefly on certain differences in the structure of the antheridial branches. The latter structures were not found in the local plants but the sequence of origin of determinate branches indicates that the plants belong to this species.

Pterosiphonia californica Kylin, Santa Catalina Island, April, 1935, *808;* near Ferry Wharf, Oakland, Alameda County, California, April, 1937, *2074;* Corona del Mar, November, 1935, *1110*. This plant was previously reported only from San Diego and La Jolla by Kylin (1941), who did not observe tetrasporic plants. The tetrasporangia are of the usual sort, occurring one per segment in the ultimate branchlets. This plant was collected by Gardner (no. *2480*) from rocks three miles west of Santa Monica as early as March, 1912, as indicated by specimens in the herbarium of the University of California at Berkeley.

Polysiphonia Eastwoodae S. & G., Cabrillo Beach, San Pedro, July, 1940, *3103*. This collection seems to belong with *P. Eastwoodae,* an entity which is possibly too close to *P. Snyderae* Kylin, but which must be kept distinct at present on account of the difference in the basal attachment. *P. Eastwoodae* was inadvertently omitted from the list of tetrasiphonous species treated in a previous paper (Hollenberg, 1942).

Polysiphonia Snyderae var. intricata Hollenberg, from rocks in the middle littoral zone, Corona del Mar, October, 1942, *3284*. This plant is a dwarf form of the variety and was found associated with other mat-forming algae. The variety was previously known only from Sonora, Mexico.

Laurencia diegoensis Dawson, Corona del Mar, October, 1934, *496*. The writer has collected this plant a number of times along the coast of southern California. In his original description Dawson (1944c) points out that the plant occurs farther north than the type locality, La Jolla. It is a very distinctive plant as much as 22 cm. high. A characteristic feature not pointed out by Dawson is the unilateral position of the male conceptacles. There may be as many as four of these conceptacles bulging prominently on the adaxial side of the ultimate ramuli.

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ON TWO PERENNIAL CAESPITOSE LEPIDIUMS OF WESTERN NORTH AMERICA

Reed C. Rollins

Among the known North American species of *Lepidium, L. nanum* S. Wats. stands out as strikingly different in habit from all others. It is a low, matted plant with many caudex branches each terminated by a dense rosulate cluster of tiny leaves. The species has a well-developed taproot system that often penetrates the soil to depths of a foot or more. It grows at relatively low elevations in northern Nevada. As Hitchcock (1936) remarked, plants of this species are "more suggestive of *Draba* than of *Lepidium.*" In the past, speculation as to the genetic relationships of *L. nanum* inevitably lead to a comparison of it with species of similar habit of the high Andes of South America. For example, Thellung (1906) expressed the opinion that the Andean *L. Meyenii* Walp. was probably a relative of *L. nanum.*

As long as *L. nanum* remained the only species of its type known from North America, it was justifiable to try to link it up with such remotely situated species as those of the South American continent. In fact, no obvious alternative existed because there has been no basis for connecting *L. nanum* with any other North American species of the genus. However, the recent discovery of a new species from Idaho[1] has supplied a probable connecting link between *L. nanum* and other perennial North American species. The new species is caespitose and possesses a very thick taproot (pl. 22, fig. 1). It stands in an intermediate position morphologically between *L. nanum* and such other

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[1] Professor Ray J. Davis discovered fruiting material of the new species in June, 1946, returning to the same location in May, 1947, for flowering specimens.

Explanation of Figures. Plate 22.

Plate 22. Lepidium Davisii. Fig. 1, a plant from the type sheet. It is 16 cm. wide. Fig. 2, enlarged infructescence. The siliques are 3–3.5 mm. long.

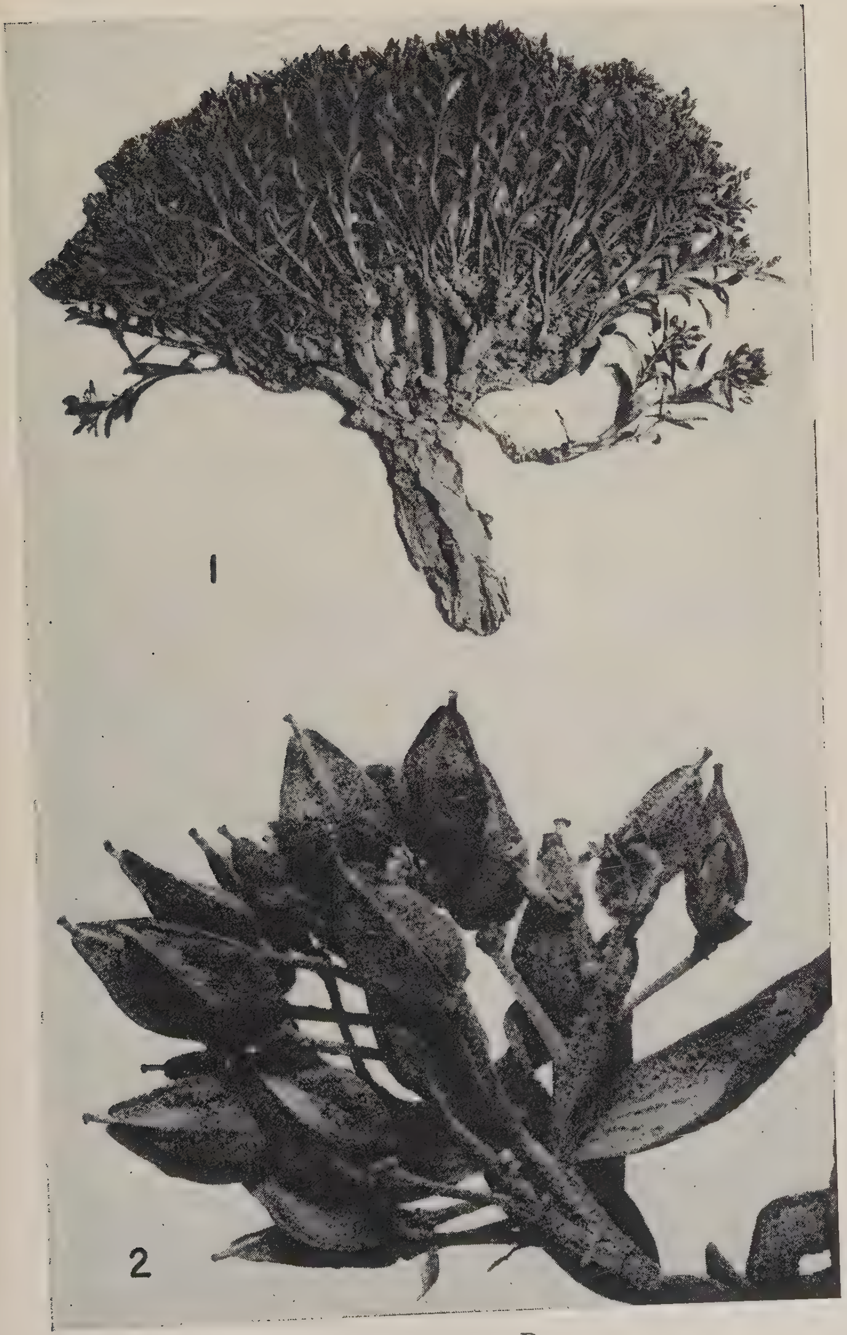

Plate 22. Lepidium Davisii.

perennial species of *Lepidium* as *L. montanum.* Therefore, it is now plausible to suggest that *L. nanum* may be related to other North American species of *Lepidium.* Formerly such a hypothesis would have seemed completely untenable. It is the principal purpose of the present paper to present a description of the new plant.

Lepidium Davisii sp. nov. Herba perennis caespitosa multicaulis; caudicibus ramosis, ramis crassis; caulibus erectis simplicibus vel rare ramosis 4–8 cm. altis pubescentibus; foliis sessilibus integris spathulatis sparse pubescentibus 1–2.5 cm. longis, 2–5 mm. latis; inflorecentiis subcorymbosis; sepalis oblongis ca. 1.5 mm. longis, ca. 1 mm. latis; petalis albis spathulatis 2–3 mm. longis; pedicellis pubescentibus teretibus 3–4 mm. longis; siliquis ovatis glabris vel sparse pubescentibus 3–3.5 mm. longis; stylis ca. 0.5 mm. longis; cotyledonibus accumbentibus.

Caespitose deep-rooted perennial forming clumps; roots thick and fleshy, 0.5–2 cm. across, expanded at summit and divided into numerous caudex branches; caudex corymbose, the apex of the branches partially invested in old leaf-bases; stems slender, numerous, each terminated by an inflorescence, simple or rarely branched, leafy, 4–8 cm. high, densely pubescent with minute whitish simple trichomes; leaves sessile, basal and cauline similar, spatulate, obtuse, greenish, sparsely pubescent, much-exceeding the internodes, 1–2.5 cm. long, 2–5 mm. wide; inflorescence subcorymbose, slightly elongated; sepals broadly oblong, not persistent, greenish with a broad hyaline margin, ca. 1.5 mm. long and 1 mm. wide, glabrous to very sparsely pubescent near the base; petals white, spatulate, 2–3 mm. long, ca. 1 mm. wide above; paired stamens only slightly longer than single stamens; infructescence subcorymbose; pedicels divaricate, pubescent, terete, 3–4 mm. long; siliques crowded, ovate (pl. 22, fig. 2), glabrous to sparsely pubescent, slightly winged above, flattened contrary to replum, slightly notched at apex, 3–3.5 mm. long, 2–2.5 mm. wide; styles ca. 0.5 mm. long; seeds wingless, one in each locule; cotyledons accumbent.

Type in the Dudley Herbarium of Stanford University, collected June 27, 1946, in a dried-up pond of the lava plain, ½ mile north of the Snake River Canyon, about 14 miles south of Mountain Home, Elmore County, Idaho, *R. J. Davis 4670.* A second collection from the same station was taken May 9, 1947, *R. J. Davis 4745* (DS).

The siliques of *L. Davisii* are similar in shape to those of *L. nanum.* The seeds are of similar size and shape, and the cotyledons are accumbent in both species. As pointed out above, the caespitose habit and thick perennial root further suggest a possible relationship between these species. These and many other kinds of plants of similar growth-habit are found in arid areas at relatively low elevations in the intercordilleran region of western North America. Such plants are often mistakenly assumed to be part of a high mountain arctic-alpine flora. Thellung (1906) made such a mistake when he referred to *L. nanum* as an alpine plant.

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REVIEW

The Genus Crepis. Part I. The Taxonomy, Phylogeny, Distribution, and Evolution of Crepis. Part II. Systematic Treatment. By ERNEST BROWN BABCOCK. University of California Publications in Botany, vol. 21, pp. xii + 1–198, frontispiece, plate 1, figs. 1–11, tables 1–12; vol. 22, pp. x + 199–1031, plates 2–36, figs. 12–305, tables 13–19. 1947.

Hieracium excepted, *Crepis* is the largest genus of the tribe Cichorieae, family Compositae. Its one hundred and ninety-six species are distributed widely over much of Eurasia, Africa, and western North America, with their greatest concentration in the Mediterranean region. The cytology, genetics, cytogenetics, evolution, and systematics of these species have been subjected to lifelong study by Professor Babcock with the assistance of many co-workers. The results of these studies are effectively summarized in the present outstanding contribution. Space does not allow, in a short review, even mention of more than a few of the important and fundamental discoveries. Those who desire to know more will have to consult the original source which will surely become one of the classics of systematic botany.

Professor Babcock is one of the pioneers of the modern idea that systematics should correlate and integrate all evidence pertinent to the interrelationships of organisms, regardless of its source, and the present study fully substantiates that thesis. The primary sources of evidence are the classic criteria of comparative morphology and geographical distribution, yet these in themselves may not be always reliable, and the instances in which evidence from comparative cytology, genetics, cytogenetics, or geology has proved critical are legion. Once all of the facts are assembled, the evidence from each of these sources strengthens that from each other, and as a whole points to a definitive and unequivocal conclusion. On this broad basis of fact, gleaned from many diverse approaches, though still incomplete in places, Professor Babcock's conclusions rest, and it probably is no overstatement that no systematic work of comparable magnitude has ever rested on a firmer foundation.

On the basis of comparative morphology, *Crepis* is divided into primitive, intermediate, and advanced groups of species. These groups, though often referred to, are not given taxonomic status, their relationship being horizontal rather than vertical. The most primitive species are those with perennial rhizomes, large lyrate leaves, and few large heads with very large florets and achenes, and an involucre consisting of many large bracts which remain unchanged at maturity. These are obviously adapted to a mesophytic climate, and are presumed to have persisted with little change since their origin, perhaps in the middle of the Tertiary period. The most advanced species include those of short-annual duration, with tap roots, smaller dissected leaves, and numerous small heads with small florets and achenes, and an involucre of few small bracts which become thickened at maturity. These have become specialized to xeric conditions, and are much more recent in origin. Between these two extremes are found most of the species of *Crepis,* specialized in one way or another along several different lines of development.

One hundred and thirteen species have been studied cytologically. These, excluding ten North American species of the section Psilochaenia, which are polyploid, $x = 11$, and six polyploid Old World species, are all diploid, $n = 7, 6, 5, 4$, or 3, with 4-paired species greatly predominating. Six is held to have been the primitive basic number of chromosomes, this number being possessed by some of the most primitive rhizomatous species, with 5, 4, and 3 being derived through a progressive series of reductions. This is correlated with a decrease in chromosome symmetry, and a decrease in chromosome size, and each step is thought to have occurred independently on several occasions. The group of species with $n = 7$, the section Ixeridopsis, is not the most primitive, and because of morphological and cytological resemblances is assumed to have arisen through intergeneric hybridization with *Ixeris.* Another group, the section Pyrimachos, which has not been studied cytologically, and a single aberrant species, *C. paludosa,* $n = 6$, may also have arisen by intergeneric hybridization. Aside from these three possible exceptions, the morphological and cytological evidence supports the generalization that *Crepis* is monophyletic.

The evidence from genetics and cytogenetics also is limited by the number of species which it has been possible to bring into cultivation. This evidence is extensive, however, many species having been crossed, and the resulting hybrids studied. In general, the more closely related the species, the more readily they may be crossed, the more vigorous and fertile the offspring, and the more nearly homologous the chromosomes as revealed by meiotic pairing. From this and the occurrence of similar genic mutations in widely separated species, it is inferred that the genetic background is similar in all of the species investigated. This in turn supports the hypothesis of monophylesis. It follows that evolution in *Crepis* has taken place on the diploid level through the accumulation of genic mutations, and a rearrangement of these genic materials through chromosome changes. Polyploidy and intergeneric hybridization have been relatively unimportant as far as the genus as a whole is concerned.

On the basis of comparative morphology, geographical distribution, and chromosome numbers, it is inferred that the twenty-seven genera of the subtribe Crepidinae including *Crepis,* originated from the primitive genus *Dubyaea* or now extinct *Dubyaea*-like species. That the genus *Crepis* originated in central Asia near the middle of the Tertiary period is supported by geological, geographical, and biological evidence. It is from this area that the natural phyletic lines in the genus radiate. Relics of the putatively ancestral genus are preserved nearby, as are primitive members of related genera. These primitive members of *Crepis* and those of related genera are mesophytes which in itself suggests a temperate mid-Tertiary development. That this is a likely hypothesis is shown by a review of Tertiary history.

Matthew's principle is called on for additional support of the central Asiatic origin of *Crepis.* It is true that the distributions of some of the primitive species do conform to this dictum, but the dictum itself rests on the unsupported premise that evolutionary forces are most effective at the center of origin, hence each successive wave of outward migration would be more advanced than those that have gone before. Thus, assuming the distribution of each to be a function of time, uninfluenced by other factors, this would result in the occurrence of the primitive members at the periphery of the range of the group. That the conformity with Matthew's principle is coincidence only is evident from a similar examination of the Crepidinae, the most primitive members of which are found nearer the supposed center of origin than are many of the obviously derived members, or the observation that modern genetic theory, as clearly outlined in the treatise, lends no support whatsoever to any such principle of distribution. It is most unfortunate that the author, who must be fully aware of these conflicts, does not resolve them, for it is certain that less profound thinkers will seize upon this coincidental conformance as confirmation of the principle of Matthew by evidence from modern genetics.

The second volume is a model of systematic conception and execution. First, it includes the history and description of the genus, followed by diagnoses of and keys to the twenty-seven natural sections. These are then taken up, one by one, in order from primitive to intermediate to advanced. This order admittedly is progressive rather than phyletic, for phyletic relationships may be other than linear. With some exceptions, each sectional treatment is introduced by a discussion of relationships and distribution of the species, usually illustrated with a map and accompanied by a key to the species. Then follow the treatments of individual species, again arranged in a progressive sequence. The descriptions are detailed and comparable point by point. Each species is illustrated with a figure, usually showing habit as well as other diagnostic features including the chromosome set when this is known for the species. The figures are drawn to the same scale and, again, are directly comparable. Following the specific description is a statement of geographical distribution and ecological relationships. Then comes the citation of critical specimens, followed by notes on the variability of the species, often including a numbered list of variants held to be minor. Concluding is a statement of specific relationships based on a synthesis of all available evidence. In those cases in which there is more than one subspecies, slight departure is made from the above sequence, but the treatment again is consistent.

Professor Babcock, whose achievements in genetics and evolution are widely recognized, is to be congratulated on this outstanding triumph in systematics. Likewise, the wise and far-sighted policy of the administration of the California Experiment Station, in supporting this excursion into pure science for more than a quarter of a century, is to be highly commended. It is only from unqualified support such as this that truly great advances in science may be expected.—Marion Ownbey, State College of Washington.

NOTES AND NEWS

A Possible Record of Quercus Morehus in Oregon. An interesting oak thought to be *Quercus Morehus,* has been found along the Lower Grave Creek County Road about 6.2 miles west of Leland, northern Josephine County (Sect. 32 or 33 S., T. 33 S., R. 7 W., Willamette Meridian). To date, only leaf specimens have been collected, but if the tree proves to be *Q. Morehus,* it will be the first record of the occurrence of this species in Oregon.—Oliver V. Matthews, Salem, Oregon.

A small residue of back numbers of the biological journal, "Zoe", published by T. S. and Katharine Brandegee from 1890 until 1908, has come to light. From volume I, numbers 1, 2, 3, 6, and 8 are missing; from volume II, numbers 1 and 2 are missing; volumes III and IV are complete; volume 5 is complete except for number 1. Information concerning this material may be obtained from the secretary of the California Botanical Society.